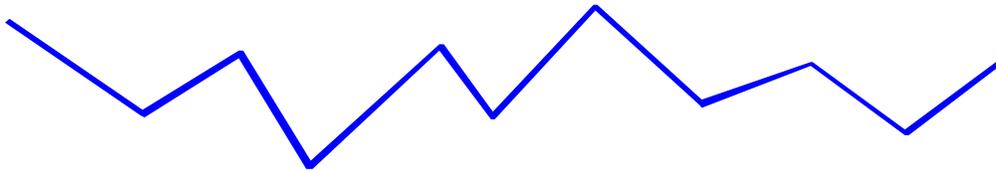


Reviews of Economic Development
Literature and Practice: No. 12



Rural Knowledge Clusters: The Challenge of Rural Economic Prosperity

Lee W. Munnich, Jr.
Greg Schrock
Karen Cook
University of Minnesota

2002



U.S. Economic Development Administration

Reviews of Economic Development Literature and Practice: No. 12

**RURAL KNOWLEDGE CLUSTERS:
THE CHALLENGE OF RURAL
ECONOMIC PROSPERITY**

August 2002

Lee W. Munnich, Jr.
Greg Schrock
Karen Cook



State and Local Policy Program
HUBERT H. HUMPHREY INSTITUTE OF PUBLIC AFFAIRS
UNIVERSITY OF MINNESOTA

This Report Was Prepared under an Award from the
U.S. DEPARTMENT OF COMMERCE
ECONOMIC DEVELOPMENT ADMINISTRATION

EDA Project No. 99-07-13816



This publication was prepared by the State and Local Policy Program of the University of Minnesota's Hubert H. Humphrey Institute of Public Affairs. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of the Economic Development Administration.

The Humphrey Institute of the University of Minnesota is hospitable to a diversity of opinions and aspirations. The Institute does not itself take positions on issues of public policy.

CONTENTS

Contents	i
Figures	iii
Introduction – The Challenge of Regional Prosperity	1
Industry Clusters as a Model of Regional Development	2
Rural Industry Clusters – Evidence and Implications	5
Rural Knowledge Clusters – A Better Explanatory Framework?	7
Operational Challenges to Defining Rural Knowledge Clusters	7
Knowledge and Clustering	8
Hypotheses about Rural Knowledge Clusters	9
Evidence from Three Rural Knowledge Clusters in Minnesota	9
1. Mankato.....	9
2. Alexandria	10
3. Northwest Minnesota	11
Implications for Economic Development	14
Conclusion	15
Annotated Bibliography	16
Complete Bibliography	25
Related EDA Studies	31

FIGURES

Figure 1. Michael Porter’s Diamond of Advantage	3
Figure 2. Four Stages of Industry Cluster Strategies	4
Figure 3. Rural Minnesota Industry Clusters	5
Figure 4. Three Rural Knowledge Clusters in Minnesota.....	13

Introduction — The Challenge of Rural Economic Prosperity

The implications of globalization for economic development have been dramatic. Firms and industries face a double-edged sword — access to global markets but exposure to global competition. In this new competitive climate, firms and industries producing innovative, high-value products are prospering while those producing standardized, high-volume, low-value products are not. Additionally, industries historically accustomed to insulation from global competition are adjusting less favorably to this new economic context. Globalization creates a market for cheaper imports that easily substitute for domestic goods (Torgerson and Hamrick 1999).

Rural areas face formidable challenges to economic prosperity in an increasingly knowledge-based economy. Generally, rural areas produce goods that are vulnerable to changing export conditions. The traditional sources of rural economic competitiveness such as access to natural resources and relatively lower costs are encountering declining transportation costs and market globalization. Disadvantages of both geographic (inability to achieve equivalent economies of scale and specialized division of labor) and structural natures (migration from rural communities) help to explain the underperformance of rural economies relative to urban ones.

Although agriculture remains an essential staple of the rural economy, manufacturing also plays an important role. Their importance to rural economies is changing however, for example, the nature of agriculture is evolving from an income-earning family business into large-scale farming corporations. Many individual farms remain in production only if they grow specific crops as part of a supply chain (Drabenstott 2001). Otherwise, corporate farming is crowding them out. Manufacturing is experiencing a decline in demand for its goods while remaining demand faces competition from cheaper imports (Torgerson and Hamrick 1999). Many view jobs in the manufacturing industry as requiring “older skills” that do not necessarily mesh with the new knowledge economy. Thus, rural areas relying on manufacturing industries tend to add lower-paying jobs at the expense of higher-paying ones (Henry and Drabenstott 1996). Since the early 1980s, the wage gap between metro and nonmetro counties has become significant. In 1998, average earnings in nonmetropolitan counties were at a historical low of 69.1 percent of metro earnings (Gale and McGranahan 2001). Stauber (2001) asserts that continuing to focus on agriculture and manufacturing will hurt rural economic development.

Rural areas as a whole have lower levels of educational attainment, patenting, and venture capital investment than metropolitan areas. Consequently, rural economies consistently underperform in high-technology industries and activities in which knowledge (education), translated into innovation (patenting), forms the only enduring source of competitive advantage. High-technology industry clusters are limited to relatively few U.S. metro areas (Cortright and Meyer 2001). The infrastructure necessary for supporting this type of industry cluster is often not available in rural areas (Drabenstott 2001). High-technology employment in rural areas is generally limited to production-level jobs in branch plants that show few clustering tendencies (Glasmeier 1991).

In this increasingly competitive global economic climate, economic development policy makers and practitioners actively seek ways of conceptualizing and explaining successful, high-performance economies. This is true in both urban and rural economies. By understanding the fundamental mechanics of these economies, they seek effective strategies and policies to promote the economic and community vitality of the places where they live and work.

This report explores “rural knowledge clusters” as a model for high-performance rural economies. It begins with a discussion of the theory and history of industry clusters, and the application of this model to rural economies. Lessons drawn from research on rural clusters lead to a proposed model of rural knowledge clusters. Characteristics of this model are then discussed, including the importance of knowledge to cluster activity. Preliminary evidence on the application of this model to three innovative rural Minnesota economies is presented. The final sections explore the economic development implications of this rural knowledge cluster model, and the role that public policy could play in assisting with that development.

Industry Clusters as a Model of Regional Development

Industry clusters have become a popular model in the past decade for analyzing regional economies, as well as organizing strategies and policies to promote regional development. Yet, both the popularity and the simplicity of the industry cluster model belie the broad range of economic thought that precedes it.

As Feser (1998, p.19) rightly points out, “there is no theory of industry clusters, *per se*.” However, economists, geographers, and regional scientists since the time of Alfred Marshall sought to explain the complex dynamics of industrial districts. Most of this early work, including that of Allyn Young and Alfred Weber, emphasized the microeconomic benefits of industrial collocation. Their work theorized that external economies result from the agglomeration of industrial activity. This is not just from scale economies within firms, but from increased specialization and division of labor among firms, lower transaction costs, and greater access to information. The dynamic nature of these externalities promised not only lower production costs but also opportunities for innovation and cross-fertilization of technological advances (i.e., the conversion of semiconductors from military to civilian high-tech applications in Silicon Valley). This seminal work informed the emerging field of regional science and the development of industrial location theory in the 1950s and 1960s.

Deindustrialization in the 1970s and early 1980s placed renewed focus on the fundamentals of industrial location and regional competitiveness. In particular, the resilience and differential performance of successful regions and industries became the center of attention in the late 1980s. Silicon Valley and the “Third Italy” (portion of northern Italy encompassing the region of Emilia-Romagna) were models of regional development. Researchers lauded Silicon Valley, the emerging center of global high-tech development, for its freewheeling entrepreneurship and dynamic, synergistic relationships between higher education and industry (Saxenian 1994). They also noted the “Third Italy” for its “flexibly specialized” networks of small producers in relatively low-tech industrial sectors like shoe production (Piore and Sabel 1984). Countless

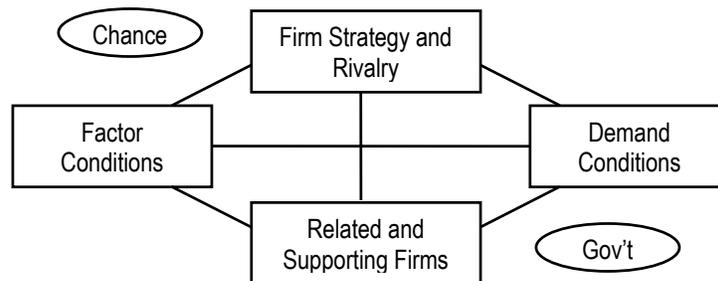
junkets of economic development researchers and policy makers visited these places to find transferable ideas for regional development.

In 1990, Harvard business economist Michael Porter drew together these rejuvenated theories of regional development with elements of business strategy into a compelling and lucid work, *The Competitive Advantage of Nations*. Porter theorized that successful industry clusters could be explained in terms of a “diamond of advantage.” This diamond consisted of four main elements:

- *Factor conditions* – a region’s endowment of factors of production, including human, physical, knowledge, capital resources, and infrastructure, which make it more conducive to success in a given industry (e.g., wood products in northern Minnesota).
- *Demand conditions* – the nature of home demand for a given product or service, which can pressure local firms to innovate faster (e.g., Italian shoe production).
- *Related and supporting industries* – networks of buyers and suppliers transacting in close proximity to foster active information exchange, collective learning, and supply-chain innovation.
- *Firm strategy, structure, and rivalry* – a climate that combines both intense competition among localized producers, with cooperation and collective action on shared needs, making it fertile for innovation and regional competitive advantage.

Additionally, Porter conferred a peripheral role to *government* and *chance* in affecting the competitive advantage and development path of industry clusters.

Figure 1
Michael Porter’s “Diamond of Advantage”



Source: Porter (1990)

While Porter’s work on industry clusters resembled existing theories of regional development in many ways, it also represented meaningful extensions of those theories. In addition to incorporating elements from his field of business strategy, Porter drew from emerging (or reemerging) theories of entrepreneurship, “creative destruction” (Joseph Schumpeter), institutional economics (Mancur Olson, Douglass North), and the importance of social relationships and social capital (Robert Putnam, Mark Granovetter). The unique synthesis, reflected in the work of Porter, Piore and Sabel, and others, caused even the late regional political economist Bennett Harrison to conclude that the

reemergence of industrial district theory was not merely “old wine in new bottles” (Harrison 1992).

From an economic development perspective, several important elements of the industry cluster framework stand out:

- *Endogeneity*: Successful industry clusters tend to possess dynamics, such as trust, competition, and entrepreneurship that lay the foundation for future success.
- *Agency*: Human agency, in the form of collective action, industry, and regional leadership, are crucial elements of ongoing success.
- *Strategy*: The strategic decisions of local firms in competition with one another helps in raising the bar for all parties.

The industry cluster model has rapidly become the focus of many economic development initiatives throughout the country. Several states, including Arizona and Connecticut, have initiated industry cluster strategies (Waits 2000), while countless cluster initiatives have focused on substate regions, metropolitan areas, and even rural regions. A recent primer on cluster-based economic development prepared for the Economic Development Administration by Information Design Associates and ICF Kaiser (1997) describes the cluster strategy process as consisting of four discrete stages: mobilization, diagnosis, collaborative strategy, and implementation (Figure 2). The nature of cluster initiatives ranges from informational (e.g., analyzing the local, regional, or state economy) to strategic (e.g., organizing public policy relating to economic development), while most incorporate some element of both.

Figure 2
Four Stages of Industry Cluster Strategies

- Stage 1: Mobilization – Building interest and participation among different constituencies needed to carry out the initiative.
- Stage 2: Diagnosis – Assessing the industry clusters that comprise the economy and the economic infrastructure that supports cluster performance.
- Stage 3: Collaborative Strategy – Convening demand-side stakeholders (companies in each cluster) and supply-side stakeholders (public and private supporting economic institutions) in working groups to identify priority challenges and action initiatives to address shared problems.
- Stage 4: Implementation – Building commitment of cluster working group participants and regional stakeholders to actions and identifying or creating an organization to sustain implementation.

Source: Information Design Associates and ICF Kaiser (1997)

Rural Industry Clusters — Evidence and Implications

To some, the notion of a rural industry cluster seems outright oxymoronic. One of the primary elements of cluster theory is that agglomeration economies resulting from urbanization and sectoral division of labor within an economy help promote specialization, productivity, and competitive advantage. These advantages of scale economies are rarely enjoyed by rural economies, as evidenced by the considerable underrepresentation of producer services in rural areas (Gale and McGranahan 2001).

Nonetheless, a considerable body of anecdotal and empirical evidence over the past decade documents the existence of innovative, successful rural industry clusters. Notable examples of rural clusters frequently cited in economic development literature include the carpet industry in Dalton, Georgia, recreational vehicles and manufactured housing in northern Indiana, furniture in Tupelo, Mississippi, and North Carolina, and houseboats in southern Kentucky (Rosenfeld et al. 2000). Examples from the Pacific Northwest include the fishing gear industry cluster in Woodland, Washington, bronze casting in Joseph, Oregon, and the sporting goods and apparel industry in Hood River, Oregon.¹

Recent work by the Humphrey Institute’s State and Local Policy Program (SLPP) also uncovered a number of successful industry clusters based in rural Minnesota. Since 1996, SLPP has conducted regional industry cluster studies in southeast (1996), southwest (1998), northwest (1998), and northeast Minnesota (2001). Each study examined four industry clusters using the Porter “diamond of advantage” framework discussed above. The diversity of industries found in rural Minnesota is quite striking. They range from traditional natural resource-based staples (food processing, forest products) to high technology (computer and electrical components) to high value-added manufacturing (recreational transportation equipment). Some are relatively mature, stable clusters (industrial machinery), while others are nascent and emerging (information technology, software). All, however, are important drivers of their respective regional economies, and marked by innovation and regional competitive advantages.

Figure 3
Rural Minnesota Industry Clusters

Southeast (1996)	Southwest (1998)	Northwest (1998)	Northeast (2001)
<ul style="list-style-type: none"> • Composites • Food Processing • Printing, Publishing, and Software • Industrial Machinery and Computer Mfg 	<ul style="list-style-type: none"> • Computer/ Electrical Components Mfg • Value-Added Ag Cooperatives • Precision Ag Equipment Mfg • Dairy Processing 	<ul style="list-style-type: none"> • Recreational Transportation Equipment • Value-Added Ag Processing • Wood Products • Tourism 	<ul style="list-style-type: none"> • Forest Products • Health Services • Information Technology • Tourism

Source: State and Local Policy Program, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota. 1996-2001.

¹ We thank Joe Cortright of Impresa Consulting, Portland, Oregon, for supplying us with these examples from the Pacific Northwest.

The evidence from qualitative studies of rural industry clusters suggests that their dynamics and structural framework may differ from urban clusters. Rosenfeld et al. (2000) posits that rural clusters can take the form of niche “micro-clusters” (i.e., houseboats in southern Kentucky), or alternatively, extensions of metropolitan clusters. While the latter are more responsive to economic development efforts, the former represent more robust characteristics of dynamism and competitive advantage, such as entrepreneurial “spin-off” activity, continuous product innovation, and differentiation. Other configurations of rural industry clusters are also likely, including “hub-and-spoke” clusters (one or two large firms surrounded by an array of smaller supplier firms) and “satellite platforms” (agglomeration of branch plants based on abundant local resources, such as timber). Much as Markusen (1996) finds with regards to industrial districts generally, the Italianate (or Marshallian) model of small firm networks tends to be less common among rural industry clusters.

What do industry clusters contribute to rural economic outcomes? Empirical studies of rural industry clusters show that where they exist, they contribute positively to regional economic growth. Henry and Drabenstott (1996, p.67) state that the evidence “points squarely at rural industry clusters as a major source of growth in rural areas” in the 1980s and early 1990s. Furthermore, Gibbs and Bernat (1998) find that rural industry clusters are associated with higher wages for rural workers.

The evidence also suggests that specialization in rural economies is associated with greater volatility. Barkley, Henry, and Kim (1999) find that rural industry agglomerations may provide a boost when the industry is growing locally, but come at the cost of greater employment losses when the industry declines. In other words, economic development strategies geared toward increasing industrial specialization may be tantamount to placing all of a region’s proverbial “eggs in one basket,” positioning it for cycles of boom or bust. For this reason, rural economic development strategies traditionally emphasized diversification (usually away from agriculture) over specialization.

This is not to say that all rural communities are in an equal position to adopt cluster-based development strategies (Barkley and Henry 1997). Trying to “seed” a cluster from scratch is almost always a recipe for failure; in such cases, a cluster-based strategy may be wholly unsuited to the region. Where assets, market opportunities, or innovative activities are present and can flourish, cluster strategies hold much more promise. In either case, the evidence suggests to not view industry cluster strategies blindly as an all-purpose means toward rural development ends.

In the end, the verdict on industry clusters and rural economies is still open to debate. Wide ranges of rural areas exhibit characteristics similar to industry clusters, despite generally smaller scale and sectoral scope. Moreover, while both anecdotal and empirical evidence associate industry clusters with positive economic outcomes; there is still considerable skepticism about the utility of the industry cluster approach in rural areas. Part of this concern likely stems from the failure of the industry cluster model to make qualitative distinctions among clusters — in other words, are all clusters created equal? The next section will address this issue, and propose a model of rural knowledge clusters to describe high-performance rural economies.

Rural Knowledge Clusters — A Better Explanatory Framework?

Dynamic and innovative, rural clusters rely heavily on a base of localized knowledge about the processes, markets, or technologies relating to the products they make. Such an observation should hardly seem surprising. Successful companies can be expected to anticipate nascent customer needs with innovative products, or meet existing needs with the newest, most efficient processes and technologies. Both require a considerable amount of knowledge. This knowledge tends to embed itself in the people and institutions that comprise the cluster.

How could a model of rural innovation address the role of knowledge? Rural knowledge clusters offer promising insights. Rural knowledge clusters are specialized networks of innovative, interrelated firms centered outside of major metropolitan areas, deriving competitive advantages primarily through accumulated, embedded, and imported knowledge among local actors about highly specific technologies, processes, and markets.

This framework augments the traditional industry cluster model by placing added emphasis on the instrumental role of knowledge as the driver of innovation and competitive advantage. This is especially important for rural economies, where advantages of agglomeration, scale economies, and highly articulated interindustry linkages — key ingredients of successful metropolitan clusters — are less evident. Furthermore, this framework is consistent with the idea of knowledge as the fundamental basis of competitive advantage in the globalized economy.

Operational Challenges to Defining Rural Knowledge Clusters

There are several operational challenges involved with defining precisely what a rural knowledge cluster is. Each constituent part of the phrase — rural, knowledge, and cluster — is marked by a certain degree of ambiguity. Even the question of what is “rural” is open to debate. Rural is often mistaken to mean “farm” when in truth it is only a small facet of the rural landscape (Drabenstott 2001). Should one consider all areas outside of federally defined metropolitan statistical areas (MSAs) as rural or is “ruralness” more subjective in nature, relating to disadvantages faced by the lack of urbanization economies enjoyed by major metropolitan areas? Isserman (2001) contends that areas we consider rural in the present time will certainly not be fifty years from now as smaller outlying areas often become absorbed into expanding metropolitan areas. While deciding what is and is not rural is not necessarily the most crucial research question, it is illustrative of challenges inherent in social science research.

By comparison, defining clusters and knowledge are more fundamental (but no less challenging) research questions. A regular critique of the industry cluster model is that it lacks definitional clarity and consistent application (Rosenfeld 2001a). Generally, including SLPP’s work on industry clusters in Minnesota, clusters have been associated with measures of industrial concentration (e.g., location quotients), growth, and competitive shift (e.g., shift-share analysis). This sometimes fails to capture very important cluster activity. While the term cluster almost self-evidently implies the existence of multiple (and competing) firms, there are also “hub and spoke” areas, where a major employer is surrounded by a host of supplier firms. This raises an important point about the potential distinctions between a knowledge cluster and an industry

cluster. While this discussion has implied that not all industry clusters are knowledge clusters, it is also conceivable that a knowledge cluster may not exhibit characteristics of an industry cluster. To the degree that knowledge about a certain process, technology, or market is diffused and externalized among localized actors and creates competitive advantages, it could be considered a knowledge cluster.

Knowledge and Clustering

If examining knowledge separately from clusters, it is important to note that knowledge is an intangible commodity, not synonymous with information. Botkin and Seeley (2001) explain that knowledge exists in two forms, codified (explicit) knowledge and tacit (informal) knowledge. While technology is allowing information to disseminate across greater distances at greater speeds, knowledge continues to cluster geographically. This is because knowledge is more complex, is embedded in individuals, and hence less readily transferred across space. In fact, Botkin and Seeley estimate that eighty percent of knowledge is tacit. This may help explain the importance of agglomeration activity and knowledge spillovers. Previous research reveals that proximity increases an industry's innovative capacity especially when firms can share ideas, products, and services (Porter and Stern 2001).

Do successful industries have more codified knowledge or tacit knowledge? Unfortunately, this is a difficult question to answer. Is it necessary to identify what type of knowledge the industry depends on in order to create a successful development model? An empirical study by Cabral and Leiblein (2001) revealed that tacit knowledge, especially in small firms, tends to disappear quickly unless it is "exploited" when workers "learn by doing." This is especially true in industries that do or should adopt higher technology. They conclude that identification of the type of knowledge used in agglomeration industries will aid in creating policy to support industry growth. Cowan and Fray (1997) state that examining the tacit knowledge used in an industry will allow for its identification; if it is identifiable, then transformation into codified or segmented knowledge is possible. This implies that knowledge could be a tradable commodity where some firms buy knowledge instead of developing their own. Crone and Roper (2001) found that multinational plants in Northern Ireland had a strongly developed knowledge base, and not only were they willing to engage in transfer activity with their local suppliers, this activity had a positive effect on competitiveness.

Why is knowledge so important to clustering activity? Cortright (2001), in his discussion of "new growth theory," asserts that knowledge, as an economic good, is different from other economic goods. Knowledge exhibits increasing returns to scale, and can be reused at almost zero marginal cost. He concludes that increasing knowledge to grow economies rather than increasing labor or capital may offer endless growth. This concept of knowledge has implications for a wide range of industries. Maskell et al. (1998) develop a model of "low-tech learning and innovation" to explain how firms in high-cost European countries compete successfully in traditional low-tech industries such as furniture and fish processing through a continuous process of knowledge creation. Audretsch (1998) asserts that these high-cost economies are still viable despite competition due to globalization because knowledge spillovers from geographic proximity and agglomeration gives them advantage over lower-cost economies. By capturing tacit knowledge, local intellectual capital may help develop products, or create

entrepreneurial and business opportunities (Jarboe 2001). Recent attempts to quantify knowledge creation and deployment have focused on patent activity (Cortright and Meyer 2001; Audretsch 1998), although the uneven nature of patenting across industries, and considerable time lag, limits their utility as a broad, cross-sectional measure. Capturing knowledge is not an easy process, especially “indigenous knowledge” that is specific to an area and difficult to capture outside of its context (Jarboe 2001).

Hypotheses About Rural Knowledge Clusters

What matters to rural knowledge clusters? First, in order to be successful, the firms within a rural knowledge cluster must enjoy some degree of *competitive advantage*, (see Figure 1). In the case of a rural knowledge cluster, these may include a rich base of skilled workers, access to proximate market opportunities, or a local entrepreneurial culture. Second, rural knowledge clusters exhibit a path of *historical* development and evolution to the local knowledge base. Knowledge rarely, if ever, appears out of thin air. It can arise through the existence of one or two essential companies, unique conditions (i.e., geographical), or other factors allowing local residents to be “in the know” about market opportunities relating to a particular product or technology. Third, rural knowledge clusters relate to both formal and informal *institutions* that have fostered the creation, diffusion, and renewal of the local knowledge base. This is highly important, given the speed with which knowledge can become obsolete economically. Institutions of higher education, including both universities and technical colleges, tend to be prominent in this regard, but informal institutions can also play a role. These three hypotheses about the nature of rural knowledge cluster drives the exploratory fieldwork conducted recently by SLPP, discussed in the next section.

Evidence from Three Rural Knowledge Clusters in Minnesota

SLPP examined three innovative and successful rural clusters in Minnesota in an effort to test the rural knowledge cluster model. The three case studies — wireless technologies in Mankato, automation technologies in Alexandria, and recreational transportation equipment in northwestern Minnesota — were chosen based on consultation with economic development analysts knowledgeable about the rural Minnesota economy. The analysts felt that these three examples may provide preliminary evidence toward the rural knowledge cluster model.

For each example, the case study methodology addressed three key questions: What is the history of this cluster, and how has the knowledge base relating to these activities developed over time? What are the present sources of competitive advantage for this cluster? Finally, what institutions have been instrumental in the development of the knowledge base?

- **Mankato: Wireless technologies**

Mankato, a small city of 30,000 people located in south central Minnesota, is the center of a diverse cluster of activities related to wireless technologies. The cluster is composed of two regional wireless service providers, Midwest Wireless and HickoryTech (spun out of the local telephone company), several mid-sized manufacturers of electronic components for wireless and communications technologies (including both locally and nonlocally owned firms), and the Institute for Wireless Education, based out

of Minnesota State University-Mankato and South Central Technical College, which provides basic and advanced informational training about wireless technologies to major wireless companies such as Nokia, AT&T, and Lucent.

Mankato's historical base of knowledge relating to wireless technologies traces back to E.F. Johnson, a manufacturer of two-way radio systems founded in the nearby town of Waseca in 1923. The presence of E.F. Johnson cultivated a strong base of local knowledge in radio frequency technologies among engineers and technicians employed by the firm. As the company's fortunes waned in the 1970s and early 1980s, a number of entrepreneurial E.F. Johnson employees struck out on their own to form new companies, including several that offer engineering and contract manufacturing for wireless and communications technology components.

Today, Mankato's primary sources of competitive advantage in wireless technologies rest with its base of highly skilled engineers and technicians, which provides a fertile environment for both the creation of startup companies and the attraction of outside companies in need of these skills and specialized knowledge. Additionally, the local educational infrastructure has continued to produce engineers and technicians with an orientation toward wireless and communication technologies. These supply-side advantages are complemented by Mankato's proximity to industry clusters where new opportunities for wireless applications are emerging, such as the medical devices in the Minneapolis-Saint Paul area. The ability of local firms to cultivate new and creative niches for wireless technologies across industries reduces the cluster's vulnerability to cyclical trends.

Both formal and informal institutions have played a role in catalyzing the development of the wireless cluster in Mankato. Likely the most important formal institutions have been Minnesota State University-Mankato and South Central Technical College, which have been instrumental in fostering the region's specialized skills base. MSU and SCTC have close connections with the local industry base, and have worked together recently to eliminate overlaps and foster cooperation between complementary programs relating to wireless technologies. Also, the Wireless & Communications Technology Alliance was recently formed to provide leadership and organizational capacity to Mankato's wireless cluster. However, informal institutions like the radio club have also been important in facilitating networking and social capital among individuals knowledgeable in wireless technologies.

- **Alexandria: Automation technologies**

Alexandria is a small city of less than 10,000 people nestled among the lakes of west central Minnesota, and is the center of a cluster of firms in the region utilizing automation and motion control technologies. While the primary base of this knowledge is located within the local packaging machinery cluster, this knowledge has been "cross-fertilized" into process technology for a diverse set of local manufacturers, resulting in considerable productivity gains. At the center of this cluster is the local technical college, which acts as a broker for these automation and motion control technologies.

Alexandria's knowledge base in automation technology relates directly to the historical strength of packaging equipment manufacturing in the region. Automation technologies are essential to industrial packaging machinery, which allow high volumes of products to be placed into shipping containers. One may understand the historic locational advantages for Minnesota in this industry in terms of forward linkages to the food processing industry and backward linkages to metalworking firms and small engine manufacturers. Today, local packaging companies like Douglas Machining and Brenton Engineering, and nearby Thiele Technologies (Fergus Falls) and Minnesota Automation (Crosby) produce equipment for use in a wide variety of industries, including automotive parts and pharmaceuticals.

The base of knowledge in Alexandria relating to automation technologies has been instrumental in its application to local companies across a broad array of manufacturing industries. The use of technologies such as programmable logic controllers (PLC) allows for the automation of wide range of manufacturing processes, enhancing product reliability and worker productivity. For example, Alexandria Extrusion Company, a mid-sized contract manufacturer of extruded aluminum parts, is one of the only companies in its field that employs automation technologies. The company credits this process innovation to its proximity to sophisticated users of automation technology in the Alexandria area.

Local institutions play a key role in promoting knowledge spillovers. The Center for Automation and Motion Control (CAMC) at Alexandria Technical College (ATC) serves as a broker for knowledge about these technologies. CAMC was formed in the early 1990s out of the college's long-standing competency in fluid power technology, and incorporates more recently developed programs in manufacturing engineering technology and machine assembly. Through its customized training programs, ATC has developed close and interactive relationships with local companies. These relationships are mutually beneficial. Companies become exposed to new technologies (i.e., automation technologies) and can equip their incumbent workers with the skills to use them, while the technical college obtains a better, "real time" source of information about the skills needed by graduates of their programs. ATC's customized training department is co-located with Minnesota Technology Inc., the state's Manufacturing Extension Partnership affiliate, allowing it leverage additional resources for manufacturing modernization efforts.

- **Northwest Minnesota: Recreational transportation equipment**

The sparsely populated northwestern corner of Minnesota is the birthplace of the snowmobile, and the home of the only two domestically owned snowmobile manufacturers, Polaris and Arctic Cat. The two companies employ over 3,000 workers in the towns of Roseau (pop. 2,750) and Thief River Falls (pop. 8,400). A more classically defined industry cluster, Polaris and Arctic Cat share a network of suppliers dispersed throughout Minnesota. In addition to producing snowmobiles, both companies expanded and diversified into the production of all-terrain vehicles (ATVs), effectively mitigating the cyclicity of the snowmobile industry. While Polaris has moved its corporate headquarters closer to the Twin Cities in recent years, this region remains the heart of

snowmobile manufacturing, and a hub for recreational transportation equipment in general.

The history of the recreational transportation equipment cluster traces back directly to Edgar Heteen, an entrepreneurial producer of farm equipment in the 1940s and 1950s. Noting the practical need for mobility during the long, snowy winters, Heteen and some colleagues began experimenting with designs for belt-driven snow-traveling machines, and soon thereafter founded Polaris. Seven years later, when Heteen left to start Arctic Cat in 1961, the rivalry began. Apparently, snowmobile racing began shortly after the construction of this second machine. The presence of these two companies a mere 70 miles away from each other engenders a competitive spirit that exists to this day.

Porter (2000) asserts that local rivalries encourage innovation and productivity growth for economic development as a whole because innovation occurs at the microeconomic level but produces macroeconomic benefits. The primary source of competitive advantage in the region for recreational transportation equipment is home demand — that is, its proximity to a demanding local customer base. While this factor was certainly important in the development of the cluster, it is equally important to its recent success. Polaris and Arctic Cat both lost considerable market share in the late 1970s and 1980s to Japanese competitors like Yamaha, Kawasaki, and Honda (in fact, Arctic Cat went bankrupt for a short period in 1981–82). Both responded by focusing on innovative, high performance machinery for the most demanding of customers — the snowmobile racing circuit. The ability to satisfy this market, which they credit to their proximity and agility in developing new ideas, in turn enhanced their ability to compete on high quality within the broader snowmobile market. This demand-driven competitive advantage can also be credited for the preponderance of recreational boat manufacturers throughout greater Minnesota.

In contrast to the previous examples, formal institutions play a less instrumental role in the historical development of this knowledge cluster. More important, perhaps, is the “racing culture” that permeates the local communities. The racing metaphor is a rich one for understanding the forces promoting competition and innovation within the cluster. However, local technical colleges, including Northland Community and Technical College in Thief River Falls, are playing a vital role in promoting continuous improvement and work force skill development for Polaris, Arctic Cat, and key local supplier firms, through customized training curricula. As the skill intensity of production jobs continues to increase in the future, the importance of local technical colleges can be expected to grow as well.

Figure 4
 Three Rural Knowledge Clusters in Minnesota:
 History, Competitive Advantages, and Institutional Drivers

	History	Competitive Advantages	Institutional Drivers
Mankato (wireless technologies)	EF Johnson, producer of two-way radios in Waseca, cultivated base of talent in radio frequency engineering; decline of company in 1970s and 1980s led to entrepreneurial spin-off activity among former EF Johnson employees; cluster currently encompasses electronic component mfg, wireless telephone service provision, and wireless education.	Strong base of engineers and technicians with experience and expertise in wireless technologies; proximity to market opportunities in related industry clusters, like medical devices in Twin Cities.	Local university (MSU-Mankato) and technical college (South Central Technical College); Wireless and Communications Technology Alliance; local radio club.
Alexandria (automation technologies)	Strong local cluster of packaging equipment manufacturers; automation technology essential to product innovation in packaging equipment; local competency developed in automation technologies among work force and local institutions.	Robust local demand for automation technology: local base of midsize manufacturers in diverse industries looking for process innovations to enhance productivity.	Center for Automation and Motion Control, customized training programs, Alexandria Technical College; manufacturing extension program.
Northwest Minnesota (recreational transportation equipment)	Snowmobile first developed in 1950s by Edgar Heteen, local producer of farm equipment; founded only two current domestically owned snowmobile producers, Polaris and Arctic Cat, which employ over 3,200 locally; expanded recently into ATV production.	Close connection to demanding local customer base (snowmobile racers); fierce competition between Polaris and Arctic Cat; both factors promote innovation.	Informal “racing culture”; local technical colleges (Northland Community and Technical College), customized training programs, continuous improvement programs.

Source: State and Local Policy Program (2002).

Implications for Economic Development

Based on the evidence presented, several components of a rural knowledge cluster approach to economic development can be identified.

- **Understand your local knowledge base.**

Assessment is always the first step to developing a plan for action. Look to your economic base and identify the specialized knowledge that propels your most innovative and successful enterprises. Where patterns exist, either clusters of firms in a similar industry or product line, or diverse firms that share a common history or underlying technology, they should be noted. Formal assessment tools, such as business visitation programs (Morse 1990) or knowledge management approaches (Jarboe 2001), may be useful in this regard. Understanding what makes your community and its economy different (Cortright 2002) may help in discovering its current and potential sources of competitive advantage.

- **Foster linkages between firms and the local institutions that support them.**

Active feedback loops between industry and local institutions, particularly educational institutions, are an important mechanism for promoting economic competitiveness. For rural knowledge clusters this is especially critical, given the centrality of human capital and work force skills, to their success. Strategies to engage local firms should focus on both the emerging work force, through school-to-work and apprenticeship programs, and the incumbent work force, through customized job training (McGranahan 2000), continuing education, and training partnerships (Dresser and Rogers 1998). The result is a win-win situation, where lines of “real time” communication from the demand to the supply side benefit both local businesses and the work force (Rosenfeld 2000, Caryannis and Alexander 1997). Other, noneducational institutions are also important. For example, public-private cluster-based economic development consortia (such as the Wireless Communications & Technology Alliance in Mankato) are crucial for bridging the public and private sectors, and focusing public investments around rural knowledge clusters.

- **Develop strategies for promoting innovation around rural knowledge clusters.**

Innovation is the most important element of rural knowledge clusters. Consequently, strategies should focus on promoting innovation and new product development. These strategies include stimulating research and development and technology transfer activity among existing firms, which can be accomplished through manufacturing extension programs and applied research centers at local universities and technical colleges (Jarboe and Atkinson 1998). Equally important, however, are policies that support new business start-ups and spin-offs. These include technical assistance to entrepreneurs, as well as access to risk capital (venture capital, “angel” investors, revolving loan funds). Relying on the success of larger firms alone will not assure ongoing dynamism and vitality. Rural knowledge clusters must encourage generative activity that builds on and sustains sources of competitive advantage.

- **Don't try to go it alone – promote a regional vision to guide local strategies.**

Economic development strategies remain notoriously local in nature, even as there is an increasing awareness that regions must work together to be effective. A rural knowledge cluster approach must recognize the need to develop a regional vision to guide local activities. This is important on a practical level, since the firms that comprise a rural knowledge cluster may be scattered throughout a given region (especially in sparsely populated areas) and draw from a specialized labor pool that is regional in nature. All levels of government have a role in promoting regional visions (Jarboe and Atkinson 1998). In addition, institutions that may be most instrumental to promoting rural knowledge clusters are typically regional in scope. This does not mean that local initiatives cannot play an important role in promoting rural knowledge clusters. It does suggest, however, that the regional interdependencies inherent in successful rural knowledge clusters make the region the most appropriate scale undertaking action (Waits 2000).

Conclusion: Designing Rural Institutions for a Knowledge-Based Economy

The rural knowledge cluster approach to economic development, like the industry cluster model that has prevailed over the past decade, is fundamentally about learning from successful regional economies. Changes in the global economy have forced both urban and rural places to focus increasingly on innovation and competitiveness, and look for creative niches and specializations. This development has posed a dilemma for rural development practitioners and policy makers looking to update their economic base to the changing contours of a knowledge-based economy. What role does a region's historical knowledge base play in creating opportunities for the future? What conditions are necessary for this adaptation and evolution to take place? How do localized institutions catalyze this process? The evidence on rural knowledge clusters presented here suggests some preliminary answers to these questions. The model requires further examination before concrete solutions arise to meet the challenge of rural prosperity in a knowledge-based global economy. Public policy requires a solid investment in the development of rural economies.

ANNOTATED BIBLIOGRAPHY OF SELECTED WORKS RELATED TO THE RURAL ECONOMY, INDUSTRY CLUSTERS, KNOWLEDGE, AND POLICY IMPLICATIONS

The Rural Economy

Drabenstott, Mark. 2001. “New Policies for a New Rural America,” *International Regional Science Review*, Vol. 24, No. 1, pp. 3–15.

Drabenstott addresses the five challenges facing rural America today and the importance of public policy in providing solutions to them. Rural America is not synonymous with farming and it alone cannot determine economic success. Drabenstott asserts that policy needs to address five areas. First, there is a widening digital gap between urban and rural areas; it is imperative that technology be available and affordable. Second, rural entrepreneurs should be encouraged and given access to resources. Third, while agriculture has a lesser role than in the past, the structure of farming itself is changing. Institutions must recognize that the new product-oriented agriculture requires a new set of policies, especially regarding supply chains, genetically modified crops, and finding appropriate crops for differing landscapes. Fourth, sustaining the rural environment will not only attract those interested in living in a nonmetro area, but also retain those currently living there. Lastly, policy needs to address the need to boost human capital in rural areas. Business will locate where there is a skilled work force and skilled workers will earn higher wages. Drabenstott concludes that it is essential to have a clear set of goals and a clear idea of what type of institution is necessary to address these challenges.

Gale, Fred, and David McGranahan. 2001. “Nonmetro Areas Fall Behind in the ‘New Economy’.” *Rural America*, Vol. 16, No. 1, pp. 44–52.

Gale and McGranahan examine why nonmetro areas are not benefiting as metro areas are in the new economy. The income gap between the two areas is widening because the ‘new economy’ focuses on service and technology industries found in metro areas, while nonmetro areas tend to rely on older skills in mass production and value-added manufacturing. Areas gain economic advantage using knowledge, information gathering and processing, and decision making. Rural areas are at a disadvantage because industries of this type tend to agglomerate in urban areas. If rural areas want to compete for the service and technology sector, they need to offer other things besides access to technology. This includes access to good schools, natural amenities, transportation networks, other infrastructure, and an educated, trainable work force. If this does not happen, the authors conclude that the income gap between the two areas will continue to widen.

Henry, Mark, and Mark Drabenstott. 1996. “A New Micro View of the U.S. Rural Economy.” *Economic Review*, 2nd Quarter 1996, pp. 53–70.

This article explains the necessity of examining individual sectors of the rural economy in order to assess its true economic performance. Previous approaches tended to compare

the urban economy as a whole versus the rural economy as a whole, which clouds patterns of performance by region. Their study shows that rural areas made gains in manufacturing but not in the new service economy. Rural areas also tended to add more low-paying jobs at the cost of higher-paying ones. Henry and Drabenstott tested the relationship between rural growth and various growth factors such as, supply and price of local inputs, industry clustering, and urban spillover. Their concern was whether these factors work together or in some combination and what the policy implications arise from any relationship. The results revealed that industry clustering provides the most growth in rural areas. Public policy should focus on specific industries and help them enlarge their role in the economy, or help an area develop an industry through assisting them in networking with nearby urban centers.

Isserman, Andrew. 2001. “Competitive Advantages of Rural America in the Next Century,” *International Regional Science Review*, Vol. 24, No. 1, pp. 38–58.

Isserman provides a historical description of rural America at three points in time, 1900, 1950, and the present. Despite some drawbacks such as limited work force and lower population densities, rural America offers amenities such as nature, recreation, broad vistas, lower crime, less congestion, less pollution, and diversity, among others. Rural areas also offer lower land and building costs, housing, labor, and taxes. What adds to rural competitive advantage is that policy required to ensure specific regions develop is less costly than broad policies designed for a singular economy. Creating policy aimed specifically at what will promote the prosperity of that particular region prevents adjusting policy, or shifting spending when these policies do not produce the desired effect in all areas. The failure of policy to recognize this allows some rural areas to wither because policy institutions will not implement regional development programs.

Marshall, Ray. 2001. “Rural Policy in the New Century,” *International Regional Science Review*, Vol. 24, No. 1, pp. 59–83.

Marshall discusses the gaps in rural economic policy and the need to shift from a wholly agricultural policy to separate policies for distinct areas. The gaps occur in two main areas. The first is rural human resource development; it is essential that new policy strengthen rural schools through expanding to international benchmarks, or by linking schools to international corporations. The second gap occurs with a lack of a coherent rural policy statement. Policy makers need to determine what makes rural policy unique and ask what the main elements associated with it are, apart from agriculture.

Stauber, Karl N. 2001. “Why Invest in Rural America – And How? A Critical Public Policy Question for the 21st Century,” *Economic Review* pp. 33–63.

Stauber examines the failure of public policy in addressing rural economic problems and suggests the policy goals needed to create effective change. Continued focus on agriculture and manufacturing is hurting rural development. Instead, Stauber asserts that rural policy should focus on keeping the rural middle class from relocating to the cities, reducing concentrated rural poverty, and sustain and improve the quality of the natural

environment. He further states that both the federal and state governments should assist development in four ways. First, increase rural human capital by supporting rural colleges and universities in high-poverty areas. Second, create new market demands and linkages to stimulate regional competition. Third, develop and use new technology to overcome remoteness and create infrastructure. Last, encourage immigration to rural communities, especially to sparsely populated, or high-poverty areas to increase human capital. Rural residents must also play a role in deciding how to develop their own economies. This ensures protection of the natural environment, the development of high-quality food, social innovation, that future citizens are well-educated and healthy, and maintaining population distributions.

Torgerson, David, and Karen Hamrick. 1999. "Global Conditions Hurting Rural Economy," *Rural Conditions and Trends*, Vol. 9, No. 3, pp. 7–10.

The authors assert that globalization is hurting rural economies in America because they produce goods vulnerable to export conditions. Import substitution and declining demand for manufactured goods has decreased output in manufacturing industries. An abundance of world agriculture stocks affects export of American stocks. Any trade deficits experienced in the United States will affect rural economies more than urban ones.

Industry Clusters

Feser, E.J. 1998. "Old and New Theories of Industry Clusters," *Clusters and Regional Specialization: On Geography Technology and Networks*, London: Pion Limited.

Feser contends that despite cluster research, there is no comprehensive, precise meaning of industry clusters and a clear understanding of the dynamics involved in their growth. This has led to inconsistent policy making for cluster-based economic development. More cluster studies give rise to questions regarding the sources of externalities, from cultural and social, to economic and proximity influences. Previously, policy corrected for externalities and aided development in lagging regions. Feser contends that empirical research is necessary for understanding these problems, but it must tread carefully to balance a narrowing of definitions regarding clustering with generalizations pertaining to all industrial districts.

Gibbs, Robert M., and G. Andrew Bernat, Jr. 1997. "Rural Industry Clusters Raise Local Earnings." *Rural Development Perspectives*, Vol. 12, No. 3, pp. 18-25.

The authors examined whether the labor productivity in rural areas with clusters would produce higher wages. They found that a worker in a rural-cluster firm tends to earn thirteen percent more on average than a worker in a noncluster firm does. Clustering creates higher productivity because information flows faster among connected firms and workers, resulting in higher skill accumulation. This transfers into higher wages. Often, firms locate based on where the skill accumulation is. Gibbs and Bernat contend that younger workers possibly gain more from cluster employment because they have more

time to earn a higher wage and increase their skills. Rural areas benefit because younger workers will remain in the area, or more will move there for job opportunities which keeps up the population. This research is conditional depending on the community's ability to attract and sustain a cluster.

Henry, Mark S., David L. Barkley, and Yibin Zhang. 1997. "Industry Clusters in the TVA Region: Do They Affect Development of Rural Areas?" *TVA Rural Studies Program, Contractor Paper 98-9*, Lexington, Kentucky: University of Kentucky, December.

This article looks at options for rural development strategies, specifically whether benefits of clustering help the TVA region. A study comparing the relationship between nonmetropolitan income change in an industry and the initial level of industry activity in the Component Economic Areas nonmetro counties found a positive association between clustering and nonmetropolitan income change. If this relationship is critical to economic growth then one must ask what is necessary to promote clusters and whether this will work for the entire TVA region. The authors assert that while they do find some evidence supporting clusters, there is a danger of negative effects in declining areas in the region by concentrating industry. The authors conclude that diversification and balanced growth strategies are needed to tailor specific promotion policies to specific industries, especially by developing business retention and expansion strategies that recognize how cluster effects vary across industries.

Markusen, Ann. 1996. "Sticky Places in Slippery Space: A Typology of Industrial Districts," *Economic Geography*, Vol. 72, No. 3, pp. 293–313.

This article explores the phenomenon of "new industrial districts," which received increasing attention in the 1980s and 1990s as noteworthy models of "sticky places" where increasingly mobile ("slippery") capital has been drawn to co-locate. Markusen contends that the much-hyped Marshallian or Italianate industrial district model, which emphasizes networking activities among small, flexibly specialized firms, is not representative of most industrial districts around the world. Three alternative models — the "hub-and-spoke" district, the "satellite platform," and the "state-anchored" district — more accurately capture the differences among industrial districts, in terms of internal and external orientation and networking activity of firms, institutional context, and regional development implications. For the United States, Markusen suggests that the "hub-and-spoke" (one or two major employers with centripetal supplier networks) and "satellite platforms" (colocated branch plants with minimal local embeddedness) are most common.

Porter, Michael. 2000. "Location, Competition, and Economic Development: Local Clusters in a Global Economy," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 15–34.

Porter examines how clustering and local rivalries encourage innovation and productivity growth in economic development. Countries with clusters have a competitive advantage

over other nations because innovation occurs at the microeconomic level with macroeconomic benefits. Clustering enhances innovation, productivity, new business formation, and competition. Porter asserts that governments need to expand their economic role to include upgrading existing clusters and facilitating the development of new clusters while providing assistance to the private sector for their support. Expanding government input from solely the national level to state and local governments will assist in supporting clusters. Porter acknowledges the difficulty in creating a development approach to suit all clusters and industries but concludes that an integrated approach framing clusters in a general sense is necessary to determine the full effect of cluster theory on economic development.

Rosenfeld, Stuart A., Cynthia D. Liston, Marcia E. Kingslow, and Eric R. Forman. 2000. *Clusters in Rural Areas: Auto Supply Chains in Tennessee and Houseboat Manufacturers in Kentucky*. Carrboro, NC: Regional Technology Strategies, Inc.

The report, analyzes two clusters in the TVA region, the automotive supply industry in northern Tennessee, and the houseboat-manufacturing cluster in southern Kentucky. The authors ask whether there are benefits that spill over from metropolitan clusters to surrounding, less urban areas, whether small-scale clusters in towns and small cities act like larger clusters in more densely populated places, and whether local and state economic development agencies are aware of clustering occurring, and does it affect their practices? The automotive cluster exists in rural and metropolitan areas and spreads out in “tentacles” where there is not much indigenous growth. The houseboat industry is highly localized and is a “microcluster,” too small to register on a regional or statewide level but capturing a substantial share of the market. Rosenfeld contends that this cluster generated a number of spin-offs, creating an intense rivalry and entrepreneurship but this rivalry does not result in networking or shared vision. The authors conclude that the success and shortcomings of these case studies offer a basis for improving clustering industries.

Knowledge

Antonelli, Cristiano. 2000. “Collective Knowledge Communication and Innovation: The Evidence of Technological Districts,” *Regional Studies*, Vol. 34.6, pp. 535–47.

Antonelli examines the approaches used in determining communication and innovation in technological districts in Italy to identify their distinctive features and provide a framework for empirical analysis. He found that while location plays an important role in technological communication, technological districts differ from industrial districts in that they cannot rely solely on agglomeration for their success. Technological districts have different dynamics relating to externalities produced from knowledge sharing, and research and development opportunities. Public policy needs to appreciate the unique factors contributing to the technological externalities involved in complementary relationships. Regional policy has to expand by creating avenues for concentrating scientific and academic infrastructures through public subsidies.

Audretsch, D.B. 1998. “Agglomeration and the Location of Innovative Activity,” *Oxford Review of Economic Policy*, Vol. 14, No. 2, pp. 18–30.

Audretsch looks at why and how geography matters for innovative activity and international comparative advantage. Knowledge-based economic activity in high-cost countries allows them to maintain an advantage in the global economy over countries with lower costs and wages. This activity mostly occurs in regional clusters where knowledge spillovers allow for innovative activity. Audretsch also addresses the importance of geographical proximity to tacit knowledge and repetition required for learning. Innovation is necessary to keep wage levels growing in high-cost countries. To maintain this, public policy needs to shift away from regulation and competition policy towards promoting business and investing in research and development, human capital, and skill building, and attracting scientists and engineers. National policy making must make way for state, regional, and local actors to help create and commercialize knowledge in innovative activity.

Botkin, Jim, and Chuck Seeley. 2001. “The Knowledge Management Manifesto: Why KM Requires Community-Building,” *Knowledge Management Review*, Vol. 3, No. 6.

This article addresses knowledge management and the importance of a ‘living community’ to foster its growth. Botkin and Seeley delineate between codified (explicit) knowledge and tacit (informal) knowledge. Communities are important for knowledge management because eighty percent of knowledge is tacit; therefore, the collaborative tendencies of communities are the only way to share knowledge. In order to maintain and create healthy communities, managers must create a vision or challenge for a community, implement a schedule or pace for interaction, and combine the right set of technology and tools and interpersonal relationships between groups. Finally, managers must market and promote the community, demonstrate a ‘return’ on collaborative behavior, and report and assess what is helping or hindering the effectiveness of growth.

Cabral, Ricardo, and Michael J. Leiblein. 2001. “Adoption of a Process Innovation with Learning-By-Doing: Evidence from the Semiconductor Industry,” *The Journal of Industrial Economics*, Vol. XLIX, No. 3, pp. 269–80.

Cabral and Leiblein conducted an empirical study to determine whether there is a significant relationship between tacit knowledge and the adoption of technology in the semiconductor manufacturing industry by examining the stability of learning effects across technological generations. They controlled for size of firm, product market characteristics, and other industry characteristics to see what type of firms adopted new process technology. They discovered that in small firms, knowledge derived from learning-by-doing quickly becomes obsolete and disappears if it is not recognized and exploited. Adoption’s influence comes mainly from the immediate generation. Contrary to their hypothesis, the authors did not find a significant relationship between agglomeration and knowledge spillovers, leading them to conclude that there is no

evidence supporting regional knowledge spillovers and new technological adoption in this particular industry. Future research would likely indicate that it is important to identify the specific type of knowledge and generation-specific or generic learning that spills over to the next generations in order to create policy to support it.

Carayannis, Elias, and Jeffrey Alexander. 1997. “Electronic Commerce and Knowledge Economics, Trust and Co-opetition in a Global Environment,” *Journal of Internet Banking and Commerce*, Vol. 2, No. 3.
<http://www.arraydev.com/commerce/jibc>

Carayannis and Alexander assert that a firm’s internal resources are the biggest advantage in a global environment. Because of the relative ease in acquiring financial capital, the focus now is on acquiring and directing intellectual capital as the key to economic success. In order to achieve this success, complementary firms should co-opt with each other to achieve win-win market situations and more innovative products and technology. Co-opting allows for knowledge sharing, gains in social capital, and building trusting relationships while allowing for more innovation.

Cowan, Robin, and Dominique Foray. 1997. “The Economics of Codification and Diffusion of Knowledge,” *Industrial and Corporate Change*, Vol. 6, No. 3.

This article examines the process by which knowledge evolves in society, and spreads throughout the economy. The authors contend that tacit knowledge is not a formalized entity but the more people examine it, the easier it is to transform it into a systematic form. This means either codifying it through writing it down as a whole, or by breaking it into segments. Codifying tacit knowledge will lead to greater benefits, such as reducing acquisition costs, creating transferable commodities, reducing asymmetric information, and allowing firms to purchase knowledge instead of waiting to develop their own. In order to be successful, it is necessary to develop the codifying side of knowledge, such as messages, and models, and develop the language to complete this task. Improvements in technology will allow for some codification of tacit knowledge and stabilization of the knowledge environment.

Crone, Mike, and Stephen Roper. 2001. “Local Learning from Multinational Plants: Knowledge Transfers in the Supply Chain,” *Regional Studies*, Vol. 35.6, pp. 535–48.

Crone and Roper examined whether multinational plants in Northern Ireland facilitated knowledge transfers to their best local suppliers and what impact it may have on competitiveness and business performance. They found that multinationals had a strongly developed knowledge base and were willing to engage in transfer activity. This occurs most often in engineering plants or plants with formal partnerships with their suppliers. They also found that the transfers had a positive effect on competitiveness. Public policy should focus on creating supply chain measures to extend or strengthen local linkages and knowledge transfers where local supply chains exist. Policy must also

promote knowledge transfers from multinationals to other firms in a non-supply chain where less formal relationships exist.

Jarboe, Kenan Patrick. 2001. “Knowledge Management as an Economic Development Strategy,” *Review of Economic Development Literature and Practice*, Washington, D.C.: Economic Development Administration, No. 7.

Jarboe evaluates whether knowledge management is a useful tool for economic development. It will be useful if knowledge management incorporates new ways of capturing the new ideas and tacit knowledge of local workers. By capturing tacit knowledge, local intellectual capital may help develop products, or create entrepreneurial and business opportunities. Jarboe addresses the problem of ‘indigenous capital’ where tacit knowledge may be location specific and difficult to capture out of its context. He suggests that in order to obtain the most of economic development, access to computers and the Internet is necessary, as are the opportunities to create new information and knowledge-based enterprises. This allows for better utilization of information and knowledge. If this occurs, economies should be able to adapt to particular regions and businesses.

Policy Implications

Jarboe, K.P. and R.D. Atkinson. 1998. *The Case for Technology in the Knowledge Economy: R & D, Economic Growth, and the Role of Government*, Washington, DC: Progressive Policy Institute.

<http://www.ppionline.org/documents/CaseforTech.pdf>

This article examines the role of government in fostering growth in the knowledge economy. Knowledge is the key to prosperity in the current economy. Jarboe and Atkinson contend that policy makers must address specific areas to foster this growth. First, recognize that technology, innovation, and knowledge are critical to economic growth. Second, there is a significant private return on research and development at the firm and industry levels and an even greater return for society. Third, positive social value raises the level of investment in technology and knowledge creation above the market. Fourth, technology and knowledge interact with investment in equipment and education. Lastly, knowledge creation and technological innovation require special attention to institutional arrangements. Federal policy’s role should support R & D (non-defense) to increase per capita income, while creating certainty in the market by offering longer-term market initiatives such as tax credits. The federal government should also facilitate innovation by creating partnerships and alliances with the private sector, universities, and government laboratories. Policy makers should not expect the private sector to correct the spillover effects from positive returns.

McGranahan, David. 1999. "Advanced Technology Means Better Pay and Benefits for Workers," *Rural Conditions and Trends*, Vol. 9, No. 3, pp. 28–37.

McGranahan evaluated whether the adoption of advanced technology methods by companies attributed to higher wage growth. Since rural areas are attractive to firms trying to avoid unions, industries with advanced technology require greater skill and therefore pay more even without a union presence. While the wages are on average lower than union wages, companies may offer profit sharing and stock options, something unions do not have the power to negotiate. Rural industries vary widely in wages and benefits and McGranahan found that 'high adopters' of technology tended to offer greater wages and benefits than 'low adopters'. They also tend to offer training for those jobs. Public policy for rural areas then needs to encourage this type of technology to increase the opportunities for rural workers with moderate skill levels.

Rosenfeld, Stuart A. 2000. "Community College/Cluster Connections: Specialization and Competitiveness in the United States and Europe," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 51-62.

Rosenfeld examined four case studies, two European and two American, to illustrate the influences industry clusters and community colleges have on each other. When a community college chooses to specialize in particular skills, it has a large impact on the region it is located in, including providing jobs for workers not in an industry cluster. When industry clusters are present, the need for skilled labor provides an opportunity for community colleges to expand their curriculum, or start up in a new area and become a center of excellence. Firms save money on training costs, and workers are able to access new employment through connections and internships. Rosenfeld concludes that the relationship between these two is important because it creates a sizable pool of workers, increases social capital and tacit knowledge sharing, enhances information technology, supports more innovation, and raises wages. Striking a balance between the needs of employers and students is the key to successful specialization and competitiveness.

Rosenfeld, Stuart. 1995. *Industrial Strength Strategies, Regional Business Clusters, and Public Policy*. Washington, D.C.: Aspen Institute.

Rosenfeld's book examines how policy makers and practitioners should promote cluster-focused economic development policies. It is important that strategies for economic development build competitiveness and innovation rather than just build infrastructure. The chapters outline key concepts of clusters, data relating to their performance, identification and targeting of clusters for strategizing, case studies, and guidance for each level of government to implement cluster-based strategies. State and local governments should invest in social capital and learn what industries are necessary and feasible for growth in their region. They both need to create support for clustering activity. The federal government needs to provide leadership, guarantee services, fund cluster studies, and focus less on political jurisdictions when supporting clustering activity that moves across borders.

Waits, Mary Jo. 2000. "The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development, and Service Delivery," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 35–50.

Using case studies from Arizona, Waits examines how states need to reevaluate their role in economic development in order to provide secure, quality jobs. She contends that industry clusters are interesting to all levels of government because studying them allows for greater insight into what drives a particular region's economy, as well as any challenges they may face. If states create the opportunity for businesses to identify and solve problems that are common to each other, they will do so by co-informing, co-learning, co-marketing, co-purchasing and co-producing with each other. To be successful, states need to implement programs such as export programs and work force development systems applicable to their clusters. Waits concludes that there is no tried and true formula for determining what works for each region, therefore, public policy requires direct industry participation in program design for economic policies to be effective.

COMPLETE BIBLIOGRAPHY

Abramowitz, M., and P.A. David. 1996. "Technological Change and the Rise of Tangible Investments: The US Economy's Growth-path in the Twentieth Century," *Employment and Growth in the Knowledge-Based Economy*, Paris: Organization for Economic Cooperation Development.

Antonelli, Cristiano. 2000. "Collective Knowledge Communication and Innovation: The Evidence of Technological Districts," *Regional Studies*, Vol. 34.6, pp. 535–47.

Audretsch, D.B. 1998. "Agglomeration and the Location of Innovative Activity," *Oxford Review of Economic Policy*, Vol. 14, No. 2, pp. 18–30.

Barkley, David L. 1999. "Employment Change in the Nonmetropolitan South: An Overview of Recent Trends and Future Prospects," *Southern Rural Sociology*, Vol. 15, pp. 5–37.

Barkley, David L., Mark S. Henry, and Yunsoo Kim. 1999. "Industry Agglomerations and Employment Change in Nonmetro Areas," *Review of Urban and Regional Development Studies*, Vol. 11, No. 3, pp. 168–86.

Barkley, David L., and Mark S. Henry. 1997. "Rural Industrial Development: To Cluster or Not to Cluster?" *Review of Agricultural Economics*, Vol. 19, No. 2, pp. 308–25.

Botkin, Jim and Chuck Seeley. 2001. "The Knowledge Management Manifesto: Why KM Requires Community-Building," *Knowledge Management Review*, Vol. 3, No. 6.

Brown, Dennis. 1999. "Rural Business May Benefit from Big Transportation Funding Increases," *Rural Conditions and Trends*, Washington: USDA, Vol. 9, No. 3, pp. 38–43.

Cabral, Ricardo, and Michael J. Leiblein. 2001. "Adoption of a Process Innovation with Learning-by-Doing: Evidence from the Semiconductor Industry," *The Journal of Industrial Economics*, Vol. XLIX, No. 3, pp. 269–80.

Carayannis, Elias, and Jeffrey Alexander. 1997. "Electronic Commerce and Knowledge Economics, Trust and Co-opetition in a Global Environment," *Journal of Internet Banking and Commerce*, Vol. 2, No. 3.
<http://www.arraydev.com/commerce/jibc>

Center for the Rural Study of America. 2000. *Beyond Agriculture: New Policies for Rural America*. Kansas City: Federal Reserve Bank of Kansas City.

Cortright, Joseph. 2002. "The Economic Importance of Being Different: Regional Variations in Tastes, Increasing Returns, and the Dynamics of Development," *Economic Development Quarterly*, Vol 16, No.1, pp. 3–16.

Cortright, Joseph, and Heike Meyer. 2001. *High Tech Specialization: A Comparison of High Technology Centers*, Washington, D.C.: The Brookings Institution, Center on Urban and Metropolitan Policy.

Cortright, Joseph. 2001. "New Growth Theory, Technology and Learning: A Practitioner's Guide," *Reviews of Economic Development Literature and Practice*, Washington, D.C.: Economic Development Administration, No. 4.

Cowan, Robin, and Dominique Foray. 1997. "The Economics of Codification and Diffusion of Knowledge," *Industrial and Corporate Change*, Vol. 6, No. 3.

Crone, Mike, and Stephen Roper. 2001. "Local Learning from Multinational Plants: Knowledge Transfers in the Supply Chain," *Regional Studies*, Vol. 35.6, pp. 535–48.

de la Mothe, J., and G. Paquet. 1998. "Local and Regional Systems of Innovation as Learning Socio-Economies," *Local and Regional Systems of Innovation*, Boston: Kluwer Academic Publishers, pp. 1–16.

Dosi, G. 1996. "The Contribution of Economic Theory to the Understanding of a Knowledge-based Economy," *Employment and Growth in a Knowledge-Based Economy*, Paris: Organization for Economic Cooperation Development.

Drabenstott, Mark. 2001. "New Policies for a New Rural America," *International Regional Science Review*, Vol. 24, No. 1, pp. 3–15.

- Drabenstott, Mark, and Tim R. Smith. 1996. "The Changing Economy of the Rural Heartland." *Economic Forces Shaping the Rural Heartland*, Kansas City, Kansas: Federal Reserve Bank of Kansas City.
- Dresser, Laura, and Joel Rogers. 1998. "Networks, Sectors, and Workforce Learning." *Jobs & Economic Development: Strategies and Practice*, Robert P. Giloth (ed). Thousand Oaks, CA: Sage Publications pp. 64–82.
- Federal Reserve Bank of Kansas City. 1996. *Economic Forces Shaping the Rural Hinterland*. Kansas City: Federal Reserve Bank of Kansas City.
- Feser, E.J. 1998. "Old and New Theories of Industry Clusters," *Clusters and Regional Specialization: On Geography Technology and Networks*, London: Pion Limited.
- Gale, Fred, and David McGranahan. 2001. "Nonmetro Areas Fall Behind in the 'New Economy'." *Rural America*, Washington: USDA, Vol. 16, No. 1, pp. 44–52.
- Gibbs, Robert M., and G. Andrew Bernat, Jr. 1997. "Rural Industry Clusters Raise Local Earnings." *Rural Development Perspectives*, Washington: USDA, Vol. 12, No. 3, pp. 18–25.
- Glasmeyer, Amy. 1991. *The High-Tech Potential — Economic Development in Rural America*, New Brunswick, NJ: Center for Urban Policy Research.
- Harrison, Bennett. 1992. "Industrial Districts: Old Wine in New Bottles?" *Regional Studies*, Vol. 26, No. 5, pp. 469–83.
- Held, James R. 1996. "Clusters as an Economic Development Tool: Beyond the Pitfalls," *Economics Development Quarterly*, Vol. 10, No. 3, pp. 249–61.
- Henry, Mark S., David L. Barkley, and Yibin Zhang. 1997. "Industry Clusters in the TVA Region: Do They Affect Development of Rural Areas?" *TVA Rural Studies Program, Contractor Paper 98-9*, Lexington, Kentucky: University of Kentucky, December.
- Henry, Mark, and Mark Drabenstott. 1996. "A New Micro View of the U.S. Rural Economy." *Economic Review*, Federal Reserve Bank of Kansas City) 2nd Quarter 1996, pp. 53–70.
- Information Design Associates, with ICF Kaiser. 1997. *Cluster-Based Economic Development: A Key to Regional Competitiveness*. Washington, DC: Economic Development Administration, US Department of Commerce.
- Isserman, Andrew. 2001. "Competitive Advantages of Rural America in the Next Century," *International Regional Science Review*, Vol. 24, No. 1, pp. 38–58.

- Jaffe, A., M. Trajtenberg, and R. Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations," *Quarterly Journal of Economics*, Vol. 108, pp. 577–98.
- Jarboe, Kenan Patrick. 2001. "Knowledge Management as an Economic Development Strategy," *Reviews of Economic Development Literature and Practice*, Washington, D.C.: Economic Development Administration, No. 7.
- Jarboe, K.P. and R.D. Atkinson. 1998. *The Case for Technology in the Knowledge Economy: R & D, Economic Growth, and the Role of Government*, Washington, DC: Progressive Policy Institute.
<http://www.ppionline.org/documents/CaseforTech.pdf>
- Jovanovic, B., and R. Rob. 1989. "The Growth and Diffusion of Knowledge," *Review of Economic Studies*, Vol. 56, pp. 569–82.
- Kilkenny, M. 1998. "Transport Costs, the New Economic Geography, and Rural Development," *Growth and Change*, Vol. 29, pp. 259–80.
- Kim, Yunsoo, David L. Barkley, and Mark S. Henry. 2000. "Industry Characteristics Linked to Establishment Concentrations in Nonmetropolitan Areas," *Journal of Regional Science*, Vol. 40, No. 2, pp. 231–59.
- Klier, Thomas, H. 1998. *Geographic Concentration in U.S. Manufacturing: Evidence from the U.S. Auto Supplier Industry*. Chicago: Federal Reserve Bank of Chicago.
- Lorentzen, Mark (Ed.). 1998. *Specialisation and Localised Learning*. Copenhagen: Copenhagen Business School Press, Handelshøjskolens.
- Lundvall, B.A., and B. Johnson. 1994. "The Learning Economy," *Journal of Industry Studies*, Vol. 1, No. 2.
- Malecki, Edward J. 1993. "Competitive Manufacturing in the 1990s: Implications for Rural Communities," in *Rural America and the Changing Structure of Manufacturing: Spatial Implications of New Technology and Organization*. Washington, D.C. U.S. Department of Agriculture, pp. 1–33.
- Markusen, Ann. 1996. "Sticky Places in Slippery Space: A Typology of Industrial Districts," *Economic Geography*, Vol. 72, No. 3, pp. 293–313 .
- Marshall, Ray. 2001. "Rural Policy in the New Century," *International Regional Science Review*, Vol. 24, No. 1, pp. 59–83.
- Maskell, Peter, Heikki Eskelinen, Ingajaldur Hannibalsson, Anders Malmberg, and Eirik Vatne. 1998. *Competitiveness, Localised Learning and Regional Development: Specialisation and Prosperity in Small Open Economies*. New York: Routledge Press.

- McDermott, Richard. 2000. "Knowing in Community: 10 Critical Success Factors in Building Communities of Practice," *IHRIM Journal*.
- McGranahan, David. 1999. "Advanced Technology Means Better Pay and Benefits for Workers," *Rural Conditions and Trends*, Washington: USDA, Vol. 9, No. 3, pp. 28–37.
- Morse, George (ed.) 1990. *The Retention and Expansion of Existing Businesses*. Ames, IA: Iowa State University Press.
- Parker, Eric, and Joel Rogers. 1999. "Sectoral Training Initiatives in the US: Building Blocks of a New Workforce Preparation System?" *The German Skills Machine: Sustaining Comparative Advantage in a Global Economy*, Pepper D. Culpepper and David Finegold (eds). New York: Berghahn Books, pp. 326–62.
- Piore, Michael J., and Charles F. Sabel. 1984. *The Second Industrial Divide*. New York: Basic Books.
- Porter, Michael E. and Scott Stern. 2001. "Innovation: Location Matters," *MIT Sloan Management Review*.
- Porter, Michael. 2000. "Location, Competition, and Economic Development: Local Clusters in a Global Economy," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 15–34.
- Porter, Michael. 1990. *The Competitive Advantage of Nations*, New York: The Free Press.
- Rosenfeld, Stuart A. 2001a. "Backing into Clusters: Retrofitting Public Policies." Unpublished paper. Carrboro, NC: Regional Technology Strategies, Inc.
- Rosenfeld, Stuart A. 2001b. "Networks and Clusters: The Yin and Yang of Rural Development," *Exploring Policy Options for a New Rural America*, Kansas City: Federal Reserve Bank of Kansas City.
- Rosenfeld, Stuart A., Cynthia D. Liston, Marcia E. Kingslow, and Eric R. Forman. 2000. *Clusters in Rural Areas: Auto Supply Chains in Tennessee and Houseboat Manufacturers in Kentucky*. Carrboro, NC: Regional Technology Strategies, Inc.
- Rosenfeld, Stuart A. 2000. "Community College/Cluster Connections: Specialization and Competitiveness in the United States and Europe," *Economic Development Quarterly*, Vol. 14, No. 1, pp. 51–62.
- Rosenfeld, Stuart A. 1997. "Bringing Business Clusters into the Mainstream of Economic Development," *European Planning Studies*, Vol. 5, No. 1, pp. 3–23.

- Rosenfeld, Stuart A. 1996. *The Phenomenon of Rural Networks in Macro-Regions: Organization of Economic Cooperation and Development*, Unpublished paper.
- Rosenfeld, Stuart. 1995. *Industrial-Strength Strategies, Regional Business Clusters, and Public Policy*. Washington, D.C.: Aspen Institute.
- Rosenfeld, Stuart. 1995. *Overachievers: Business Clusters that Work: Prospects for Regional Development*, Chapel Hill, NC: Regional Technology Strategies, Inc.
- Rosenfeld, Stuart. 1992. *Competitive Manufacturing: New Strategies for Regional Development*. New Brunswick, NJ: Center for Urban Policy Research.
- Saxenian, Annalee. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge: Harvard University Press.
- Senker, J. 1995. "Tacit Knowledge and Models of Innovation," *Industrial and Corporate Change*, Vol. 4, No. 2.
- State and Local Policy Program (SLPP). 2002. *Rural Knowledge Clusters: Implications for Minnesota State Colleges and Universities (MnSCU)*. Minneapolis: State and Local Policy Program, Humphrey Institute of Public Affairs, University of Minnesota.
- State and Local Policy Program (SLPP). 1999. *Industry Clusters: An Economic Development Strategy for Minnesota*. Minneapolis: State and Local Policy Program, Humphrey Institute of Public Affairs, University of Minnesota.
- Stauber, Karl N. 2001. "Why Invest in Rural America — And How? A Critical Public Policy Question for the 21st Century," *Economic Review* pp. 33–63.
- Stiglitz, Joseph. 1999. *Scan Globally, Reinvent Locally: Knowledge Infrastructure and the Localization of Knowledge*, Keynote Address, World Bank, First Global Development Network Conference, Germany.
- Torgerson, David, and Karen Hamrick. 1999. "Global Conditions Hurting Rural Economy," *Rural Conditions and Trends*, Washington: USDA, Vol. 9, No. 3, pp. 7–10.
- Waits, Mary Jo. 2000. "The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development, and Service Delivery," *Economic Development Quarterly*, Vol. 14, No.1, pp. 35–50.
- Wojan, Timothy R. 2000. "The Composition of Rural Employment Growth in the 'New Economy'," *American Journal of Agricultural Economics*, 82, pp. 594–605.

RELATED PAST EDA STUDIES

Research Reports

Baker, John D. et al. 1996. *Attracting High-Wage, High-Growth Industries to Rural Areas Texas*. Workforce Development Network, Austin, Texas.

Gollub, James O., et al. 1997. *Cluster-Based Economic Development: A Key to Regional Competitiveness*. Information Design Associates, Mill Valley, California.

Gollub, James O., et al. 1997. *Cluster-Based Economic Development: A Key to Regional Competitiveness – Case Studies*. Information Design Associates, Mill Valley, California.

Leatherman, John C. 2000. *Internet-Based Commerce: Implications for Rural Communities*. Kansas State University, Manhattan, Kansas.

Cortright, Joseph. 2001. *New Growth Theory, Technology and Learning: A Practitioner's Guide*. Impresa Inc. Portland, Oregon.

Harrison, Bennet, and Marcus J. Weiss, et al. 1997. *Rethinking National Economic Development Policy*. Economic Development Assistance Consortium, Boston, Massachusetts.

National Technical Assistance Reports

Bowsher, Prentice, and Kathy Desmond, Christopher Johansen, Laura McGrath, Amee Olson, and Alice Shabecoff. 1993. *Case Studies on Rural Community-Based Development*. Community Information Exchange, Washington, DC.

Jarboe, Kenan Patrick. 2001. *Knowledge Management As an Economic Development Strategy*. Athena Alliance, Washington, DC.

Bosworth, Brian R. and Stuart A. Rosenfeld. 1995. *New Strategies for a Regional, Private Sector-Driven Approach to Modernizing the Manufacturing Base of New England*. Regional Technology Strategies Inc., Chapel Hill, North Carolina.